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M11467X

INSTRUCTION MANUAL

GENERAL ELECTRIC CO.
Instrumentation & Control
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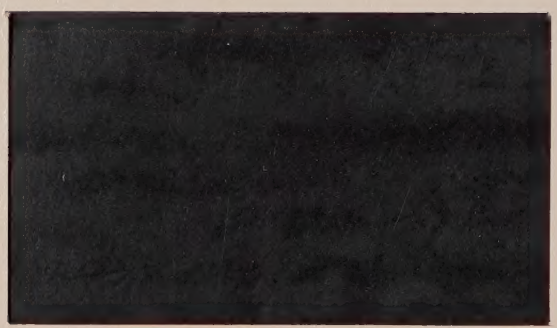
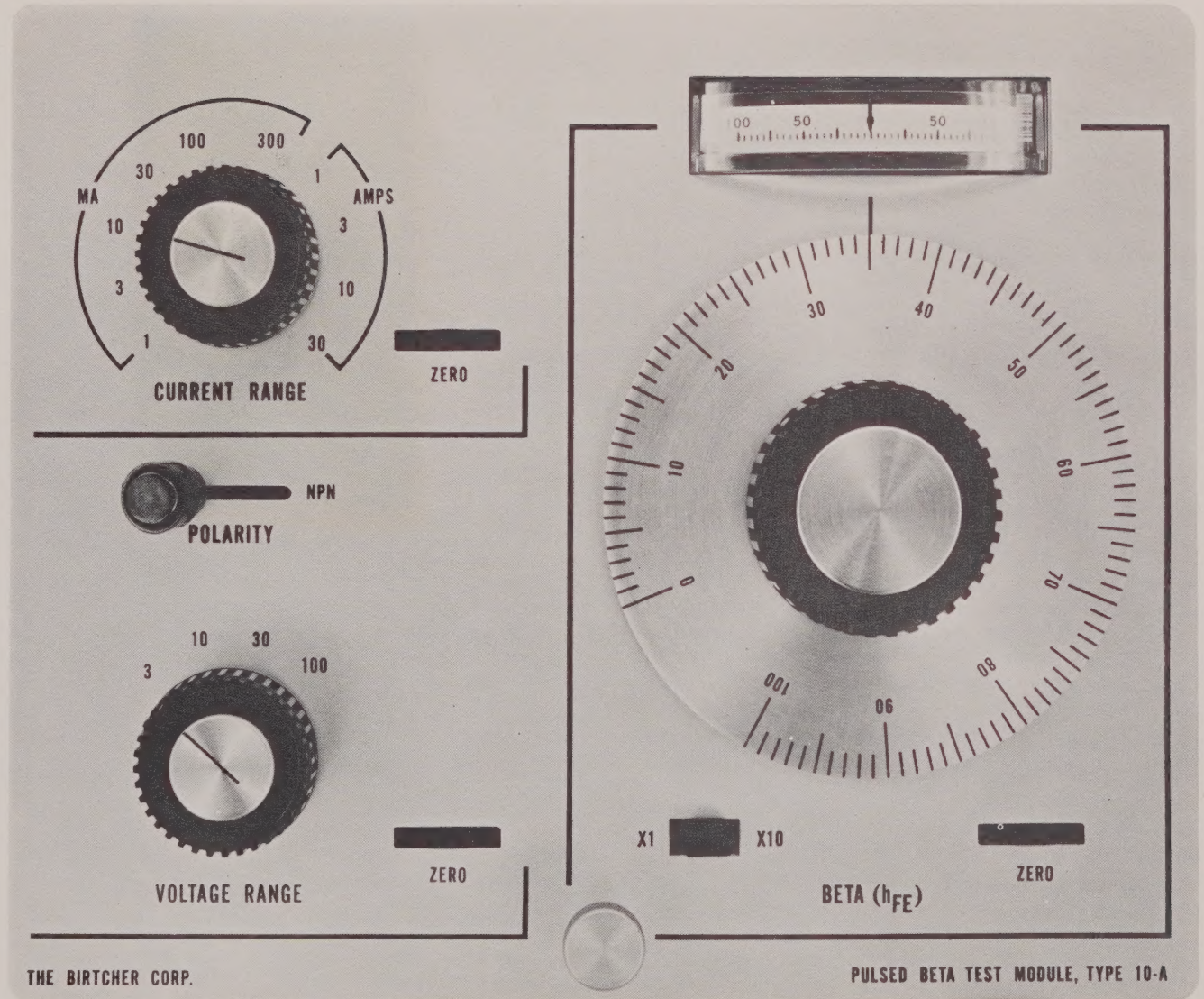
THE BIRTCHER CORPORATION INDUSTRIAL DIVISION
745 SOUTH MONTEREY PASS ROAD, MONTEREY PARK, CALIFORNIA



TYPE 10-A

TRANSISTOR PULSED h_{FE}
TEST MODULE


MA
100
300
30
1
AMPS
10
3
3
10
1
30
CURRENT RANGE
ZERO
NPN
POLARITY
10
30
3
100
ZERO
VOLTAGE RANGE
100
50
50
30
40
20
50
10
60
0
70
100
80
90
X1
X10
ZERO
BETA (h_{FE})
THE BIRTCHER CORP.
PULSED BETA TEST MODULE, TYPE 10-A

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SECTION 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

The type 10A transistor pulsed beta test module is used with the Birtcher Model 70 Semiconductor Test Set to provide direct reading of transistor h_{FE}.

A pulsed current supply permits up to 30 amperes I_C at low duty cycle to minimize heating.

1.2 SPECIFICATIONS

Collector Current Ranges:

1, 3, 10, 30, 100, 300 milliamperes,
1, 3, 10, 30 amperes.

Collector Voltage Ranges:

3, 10, 30, 100.

Duty Cycle:

2% (167 microsecond pulse width, 120 cps repetition rate).

h_{FE} Ranges:

0-100, 0-1000.

Accuracy:

I_C, V_{CE} Meters $\pm$ 3% of full scale. h_{FE} $\pm$ 1½ division on h_{FE} dial.

Construction:

Aluminum alloy chassis; anodized aluminum front panel with three-color silk screen markings.

Weight:

10 pounds.

Dimensions:

8½" wide X 7" high X 13" deep.

SECTION 2
OPERATION

2.1 GENERAL OPERATION

For ease and convenience of operation, the front panel of the Model 70 Semiconductor Test Set, including the type 10A Transistor Pulsed h_{FE} test module, has been divided into three functional sections (figure 2-1).

To aid the operator in learning and remembering the basic operation of the instrument, different colors are used for the markings in each section. Black markings refer to the collector current controls and meter. Red markings refer to collector voltage controls and meter. Blue markings refer to h_{FE} readout controls.

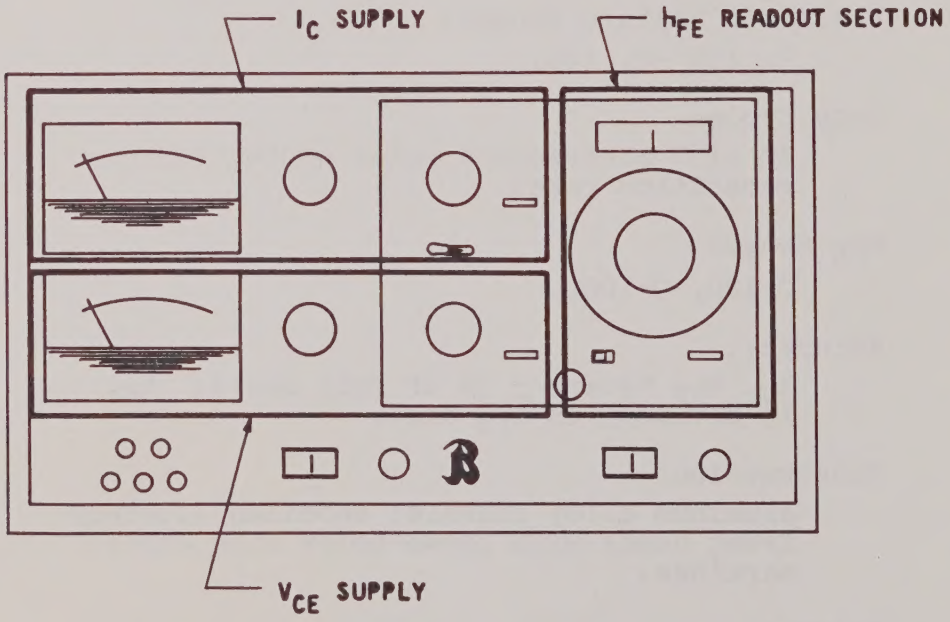


FIGURE 2-1

FRONT PANEL LAYOUT - MODEL 70 WITH 10A INSTALLED

2.2 FUNCTION OF CONTROLS AND METERS

CURRENT RANGE Switch
10 Position rotary switch provides selection of Collector Current Supply and meter (upper, Model 70) ranges. Black Markings.

2.2 FUNCTION OF CONTROLS AND METERS (continued)

ADJUST Control (Upper, Model 70)
Uncalibrated control used to adjust Collector current to transistor under test. Black Markings.

METER (upper, Model 70)
Dual scale, Mirror backed meter; indicates collector current applied to transistor under test. Ranges are selected by CURRENT RANGE Switch.

CURRENT RANGE-ZERO Adj.
Potentiometer used to zero I_C meter after warm-up. Black Markings.

VOLTAGE RANGE Switch
Four position rotary switch provides selection of collector voltage supply and meter (lower, Model 70) ranges. Red Markings.

ADJUST Control (Lower, Model 70)
Uncalibrated control used to adjust voltage applied to collector of transistor under test. Red Markings.

METER (Lower, Model 70)
Dual scale, mirror backed meter; indicates voltage between collector and emitter of transistor under test. Ranges are selected by VOLTAGE RANGE Switch.

VOLTAGE RANGE-ZERO Adj.
Potentiometer used to zero V_{CE} meter after warm-up. Red Markings.

POLARITY Switch
Two position lever switch used to reverse power supply and meter polarities for testing PNP or NPN transistors.

h_{FE} X1, X10 Switch
Two position slide switch provides selection of h_{FE} dial readout ranges. Blue Markings.

h_{FE} NULL INDICATOR
Zero center edgewise meter to provide null indication.

h_{FE} DIAL
Calibrated dial directly indicates h_{FE} of transistor under test.

h_{FE} ZERO Adj.
Potentiometer used to zero h_{FE} Null Indicator after warm-up. Blue Markings.

2.3 INITIAL TURN ON AND WARM-UP

Install the 10A Test Module in the Model 70 Semiconductor test set and connect the Model 70 to a primary power source. Set front panel controls as follows:

1. Turn both ADJUST controls fully counter-clockwise.
2. Put POWER switch in ON position.
3. After a warm-up period of 1-2 minutes, Zero meters using Zero controls on module.

   NOTE: In NPN position, h_{FE} ZERO control has reverse action.

2.4 h_{FE} MEASUREMENT

Connect the Transistor to be tested to the Model 70 Semiconductor test set with either of the transistor test adapters supplied with the Model 70. If another test adapter configuration is required, connect a lead from the emitter of the transistor to the Model 70 Diode Anode terminal; connect a lead from the collector of the transistor to the Model 70 Diode Cathode terminal. These leads are used to supply voltage to the V_{CE} measuring circuitry.

Proceed to test the transistor as follows:

1. Set POLARITY switch to type of transistor to be tested.
2. Set VOLTAGE RANGE switch to specified test range.
3. Set CURRENT RANGE switch to specified test range.
4. Depress TEST switch.
5. Turn lower ADJUST control until specified test voltage is indicated on the VOLTAGE Meter (lower, Model 70).
6. Turn upper ADJUST control until specified test current is indicated on the CURRENT meter (upper, Model 70). A re-adjustment of the collector voltage may be necessary.
7. Turn h_{FE} dial for Null on Null Indicator.
8. Read h_{FE} directly from dial.

   NOTE: h_{FE} Dial reads 0-100 with h_{FE} range switch in X1 position, and 0-1000 with h_{FE} range switch in X10 position.

2.5 SPECIAL OPERATING CONSIDERATIONS

OSCILLATIONS

When checking high frequency - high gain transistors, the test circuit may oscillate, causing eratic readings or no readings at all. If oscillations are suspected they may be suppressed by connecting a non-inductive resistor in series with the base of the test transistor; The value should be as follows:

I_C RANGE	R
1 MA	1K
3	300
10	100
30	30
100	10
300	3
1 Amp	1

h_{FE} MEASUREMENTS WITH LOW COLLECTOR CURRENT

On the 1 and 3 MA I_C ranges, noise generated across the I_C measuring resistor appears as I_C on the I_C meter. This occurs with the voltage ADJUST control turned clockwise. Errors in I_C Adjustments can be eliminated by using the following test technique.

1. Proceed to test transistor using steps 1 thru 6 of 2.4.
2. Release TEST switch.
3. Adjust I_C Meter to Zero using CURRENT RANGE Zero control.
4. Depress TEST switch.
5. Proceed with test starting at step 5 of 2.4.

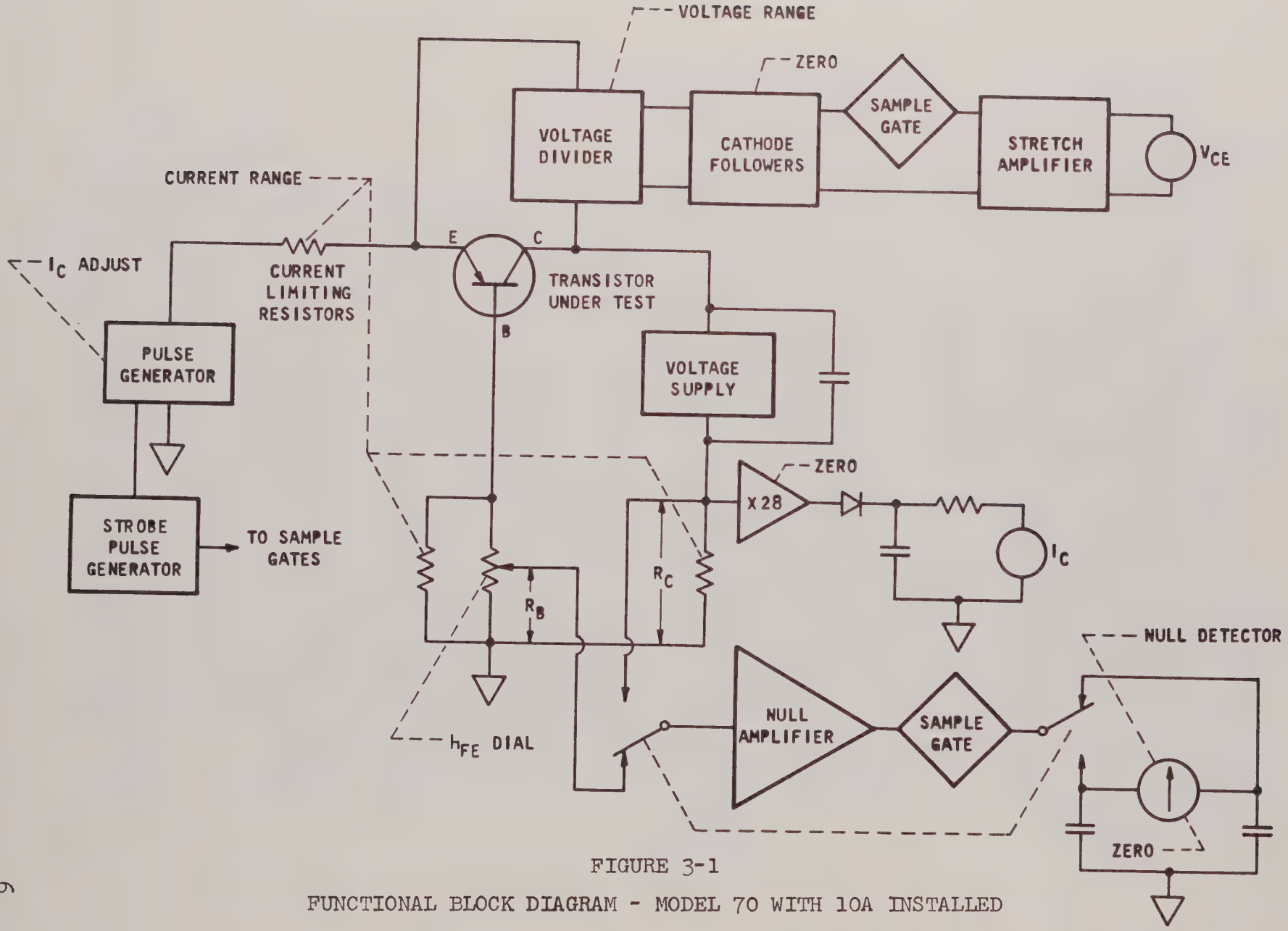


FIGURE 3-1

FUNCTIONAL BLOCK DIAGRAM - MODEL 70 WITH 10A INSTALLED

SECTION 3
THEORY OF OPERATION

BLOCK DIAGRAM

With the type 10A pulsed h_{FE} test module the transistor is connected as shown in the Block Diagram figure 3-1.

Collector Voltage is supplied by a voltage supply having a low impedance to the 170 microsecond collector current pulse.

Collector Current is controlled by a constant current pulse applied to the emitter. This biasing arrangement, permits testing transistors with varying h_{FE} characteristics without major readjustment of the I_C control.

Because of the waveforms (figure 3.2) generated in the test circuit, a sampling voltmeter is used to measure V_{CE} voltages. Sensing leads connected to the collector and emitter of the transistor under test are used to eliminate errors in V_{CE} readings caused by voltage drop in wiring.

Collector Current is measured by measuring the peak voltage developed across the I_C sensing resistor. To minimize error in peak detection of the I_C signal, the signal is amplified to approximately 28 volts and peak detected by a semiconductor diode. Peak detector output is displayed on a DC voltmeter for I_C indication.

The value of h_{FE} is derived as from the following equation:

Equation 1: By definition $h_{FE} = \frac{I_C}{I_B}$

Using ohms law

Equation 2: $I_C = \frac{V_C}{R_C}$, $I_B = \frac{V_B}{I_B}$

Substituting equation 2 in equation 1.

Equation 3: $h_{FE} = \frac{\frac{V_C}{R_C}}{\frac{V_B}{R_B}}$

Setting $V_B = V_C$

Equation 4: $$h_{FE} = \frac{\frac{I}{R_C}}{\frac{I}{R_B}}$$

Finally, re-arranging terms

Equation 5: $$h_{FE} = \frac{R_B}{R_C}$$

As can be seen from the equations, to arrive at a value for h_{FE}, the voltage developed across R_B must be set equal to R_C. This is accomplished by using a chopper to alternately sample the voltages across R_B and R_C. The signal on the arm of the chopper is amplified, and passed through a sampling gate where a second set of contacts on the chopper switch the output to stretch amplifier storage capacitors; when the voltage across R_B is equal to the voltage across R_C during the sample pulse, a null is indicated on the null meter. h_{FE} is read directly from a calibrated dial attached to the R_B potentiometer.

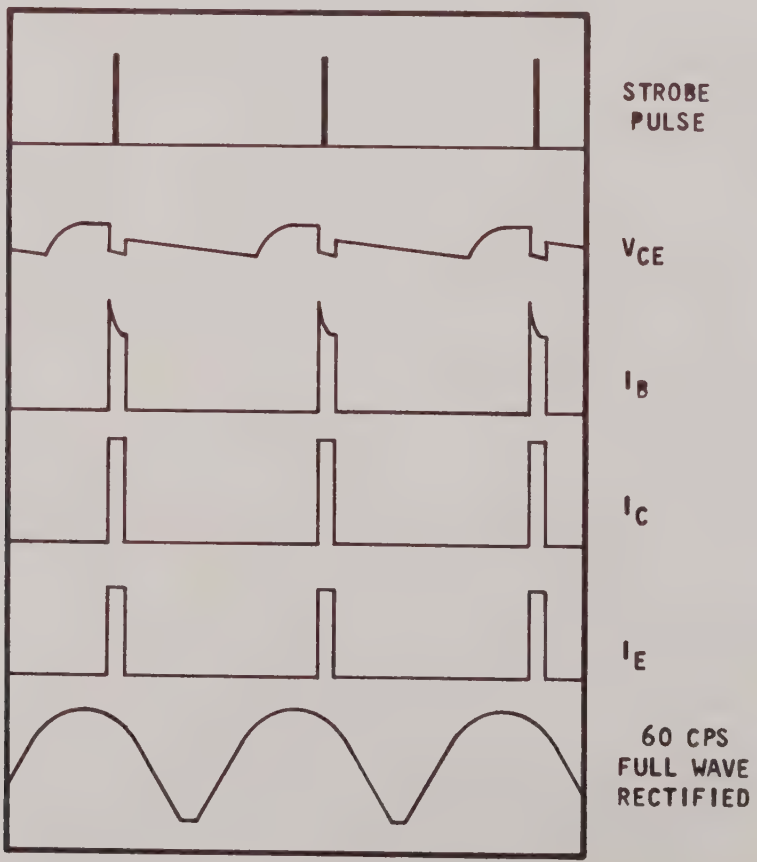


FIGURE 3.2
WAVE FORMS GENERATED IN 10A

SECTION 4
CIRCUIT DESCRIPTION

4.1 AUXILIARY POWER

Transformer T101 is used to convert 115V AC line voltage to voltages for plate and filament supplies.

Secondary winding 3 thru 5 is connected to D205A thru D to supply high voltage positive and negative full wave rectified output. C214A & B, and R269 form a capacitor input RC filter for the positive supply; output voltage is regulated by V201. The negative supply is filtered by C215 regulated by V202.

Amplifier filament voltage is supplied by secondary winding 9, 10, and 11.

4.2 EMITTER CURRENT GENERATOR

The emitter current generator provides variable amplitude 120 cps pulses to the base of the transistor under test, and delayed strobe pulses to sampling gates.

DC for the pulse generator circuitry is supplied by T102. Secondary winding (Terminals 3, 4, and 5) is full wave rectified by D103, D104 and filtered by C103. Secondary winding (Terminals 6, 7, and 8) is full wave rectified by D202 and D203.

Synchronization to 120 cps is obtained by applying the full wave rectified 60 cycle sine wave to RC Network R246, R249, and C203. When the voltage across C203 reaches approximately 10 volts, unijunction transitor Q201 goes into negative resistance state and pulse output is generated across R251. R246 provides sync adjustment.

Pulse of adjustable duration and amplitude are generated by monostable multivibrator composed of Q202, Q203 and associated circuitry. Positive triggering pulses from the sync generator are applied to the base of Q202 thru C206. Pulse duration is determined by discharge time of C205; this is adjusted by variable resistor R252. Potentiometer R103 (I_B ADJUST) in series with the collector load resistor of Q202 supplies variable amplitude pulses to the input of cascaded emitter followers Q208, Q209, and Q210. Bias for the emitter follower stages is obtained from the full wave rectified supply by D204 and C208. Polarity of the pulse is switched by S203E, F (POLARITY) in series with the input of the pulse generator.

4.2 EMITTER CURRENT GENERATOR (continued)

Relay K101 in series with the pulse output allows pulse output to be removed from test jacks between tests or when overload condition exists.

Pulse current is limited by R205 thru R214. These are selected by S202 (COLLECTOR CURRENT RANGE).

Delay of strobe pulses is obtained by using the positive pulse output on the collector of Q203 to charge RC Network R256 and C209 in the emitter circuit of a second unijunction transistor Q209.

The strobe pulse width is obtained by multivibrator Q206, Q207 and associated circuitry. This circuitry is similar to the emitter current multivibrator.

Output to sampling gates is provided by transformer T103. The primary of T103 is driven by an emitter follower (Q205) which is AC coupled to the collector of Q206.

4.3 COLLECTOR VOLTAGE SUPPLY

The collector voltage supply provides variable voltage to the collector of the transistor under test.

Variable transformer T104 (I_C ADJUST) supplies 60 cycle AC to the primary of T103. AC voltage generated across secondary windings is full wave bridge rectified by diodes D201 A-D. Energy for pulsed collector current is stored in C201.

Polarity of the collector voltage is switched by S203C, D (POLARITY) in series with the output of the collector supply.

Relay K101 in series with the collector lead allows collector bias to be removed from the test jacks between tests or when an overload condition exists.

4.4 V_{CE} VOLTMETER

Voltage from collector and emitter sensing leads is attenuated by divider network R215 thru R218. Polarity reversal to the input of the amplifier is made by S203 A and B.

The input stage of the amplifier section consists of twin triode V207 with both sections connected as cathode followers. R273 (ZERO) connected in the cathode of V204A is used to balance offset voltages developed in the sample gate and cathode follower stages.

4.4 V_{CE} VOLTMETER (Continued)

Voltage on the arm of R273 is applied to the input of sample gate (D207 thru D210). The sample gate is self biased; Zener diode D206 allows up to 6 volt differential between input and output of gate circuits between strobe pulses. During the strobe pulse, C219 is charged to the value of voltage appearing between the cathodes of V204.

Pulse stretching is by cathode followers V205A and B with the voltage across C219 applied to the grids. Voltage between cathodes of V205 is applied to M101 (lower, Model 70) for I_B indication. Calibration adjustment is by R316 in series with M101.

4.5 I_C METERING CIRCUIT

The voltage developed across collector current limiting resistors R215 thru R228 is used for measuring collector current. Polarity reversing at the input of the amplifier is by S203G,H.

The input signal is amplified by DC coupled amplifier and then peak detected. V206A and B form differential input stages, with cathode coupling. The plate of V206A is DC coupled to the grid of V207A by a neon glow lamp N201. A potentiometer R287 (ZERO) for adjusting plate voltage of V206B is used for balancing the amplifier. The plate of V207A is DC coupled by N202 to the grid of a cathode follower output stage V207B. Resistor R289 from the cathode provides a feedback to the input grid for gain stabilization.

The output signal is peak detected by D211 and C220. The voltage developed across C220 is measured by meter M102 (approx. 28 V full scale). Variable resistor R317 in series with M102 provides calibration adjustment.

4.6 PROTECTION CIRCUIT

The protection circuit consists of essentially two sections: the protection amplifier (including the sensing and control portions), and the power control relay, K201. Under normal conditions, overload relay K101 remains de-energized whenever the TEST-RESET switch S102 is operated to TEST. The contacts of K101 complete the circuit from the DC output voltage of rectifiers D101 and D102 to the coil of relay K201, energizing the relay. With K201 energized both base and collector supply circuits are completed, providing operating voltages to the transistor being tested.

4.6 PROTECTION CIRCUIT (continued)

Pulse output from the collector current amplifier is applied to K102. This resistor forms an intergrating network with C102. With 2% duty cycle and full scale indication on M101 the voltage developed across C102 is only 0.56 volts (2% X 28 volts). However, with continuous duty cycle as is the case with shorted or leaky transistors the voltage on C102 is equal to the peak output voltage of the amplifier. When the voltage between the emitter and base of unijunction Q102 exceeds approximately 4 volts (15% of full scale on I_C meter) it goes into a negative resistance state discharging C102 through the gate of the controlled rectifier Q101. This triggers Q101 into a conducting state, energizing K101 and causing overload indicator DS102 to come on. When K101 is energized, its contacts open and remove power from the coil of K201, opening the contacts of this relay and thus removing potentials from the transistor being tested.

When the overload condition is corrected, S102 must momentarily be opened (operated to RESET) then again closed (TEST) to restore normal operation.

4.7 h_{FE} NULL DETECTOR

Input contact (BBM) on 60 cps chopper X201 alternately sample a portion voltage developed across collector current sensing resistors R219 thru R228 and the voltage on the arm of h_{FE} readout potentiometer R243.

This voltage is amplified by a AC coupled V208A and B, and applied to the grid of cathode follower V201. Negative feedback to the cathode of V208A stabilizes amplifier gain at approx. 180.

Signal from the cathode V201 is applied thru sample gate, D213 to D216. Biasing arrangement for this sample gate is identical to the collector voltage amplifier sample gate. A second set of contacts (MBB) on chopper X201 alternately apply the output of the sample gate to capacitors C226 and C227, where amplified I_B and I_C signals are stored.

Voltage developed across these capacitors is applied to the grids of cathode followers V205A and B. Voltage between cathodes is applied to the h_{FE} null indicator M201. R313 is used to zero (center) the null indicator with no input to amplifier.

SECTION 5
MAINTENANCE

5.1 INSTRUCTION MANUAL

A Birtcher Instruction Manual usually contains hand made changes to diagrams and parts lists and sometimes texts. These changes are generally appropriate only to the instrument the manual was prepared for. These hand-made corrections show changes to the instrument that have been made after the printing of the manual.

There is a serial number on the warranty page of this manual. This is the serial number of your instrument. Be sure the manual number matches the instrument number when you order parts.

NOTE: Always include the instrument type and serial number in any correspondence regarding the instrument.

5.2 REPLACEMENT PARTS

5.2.1. Standard Components

Birtcher will supply replacement components at current net prices. However, since most of the components are standard electronic and radio parts, you can probably obtain them locally faster than we can ship them to you from the factory in Monterey Park, California. Be sure to consult the parts list to see what tolerances are required.

5.2.2. Selected Components

We specially select some of the components whose values must fall within prescribed limits. By sorting through our regular stocks the components so selected will have standard retma color coding showing the value and tolerance of the stock they were selected from, but they will not in general be replaceable from dealer stock.

5.2.3. Birtcher Manufactured Parts

Birtcher manufactures almost all of the mechanical parts and some of the components used in the instrument. If you order a mechanical part be sure to describe the part completely to prevent any unnecessary delay in filling your order. When you have any questions about mechanical parts or Birtcher manufactured components, contact our nearest field sales representative or write to the service department at the factory in Montery Park, California.

5.3 REMOVAL AND REPLACEMENT OF PARTS

The procedures required for replacement of most parts in the type 10A are obvious. Detailed instructions for their removal are not required. Other parts, however, can be best removed if a definite procedure is followed. Instruction for the removal of some of these parts are contained in the following paragraphs.

5.3.1. Replacement of Switches

Methods of removal of defective switches, are, for the most part, obvious and only a normal amount of care is required. Single wafers are normally not replaced on the switches used in the type 10A and if one wafer is defective, the entire switch should be replaced. Switches may be ordered from Birtcher either wired or unwired as desired.

5.3.2. Replacement of PC Board Components

Some components in the 10A are mounted on a printed circuit board. To avoid damage to the PC board when replacing components the following precautions should be observed:

Use a low power soldering iron (50 watts maximum).

Use only a high quality rosin core solder. NEVER A PASTE FLUX. After soldering, clean off any excess flux.

When replacing components with multiple mounting pins such as transistors, potentiometers, etc., it will be necessary to lift each pin slightly, working around the components several times until it is free.

5.4 CALIBRATION

5.4.1. Preliminary

The type 10A test module is a stable instrument and should not require frequent calibration. However, it will be necessary to calibrate certain parts of the instrument when tubes or components are changed. Also, a periodic calibration is desireable from the standpoint of preventative maintenance.

In the instructions that follow, the steps are arranged in the proper sequence for full calibration. Each numbered step contains the information necessary to make one adjustment. If a complete calibration is not necessary, you may perform individual steps.

5.4.1. Preliminary (continued)

The following equipment is necessary for a complete calibration of the 10A test module:

1. DC Voltmeter having a sensitivity of at least 5000 ohms/v and an accuracy of at least 1% @ 10 volts.

2. Differential input DC coupled oscilloscope having sensitivity of at least 1 volt/cm, with input attenuator - Calibrated sweep rates of 100 msec, 1 msec and 10 msec/cm. (Tektronix 503 or equivalent).

3. Birtcher type B5538 power transistor test adapter.

4. Birtcher type B5536 module connector cable. (Not necessary, but helpful).

5. 1 and 0.1 ohm $\frac{1}{2}\%$ $\frac{1}{2}$ watt resistors.

Connect 10A test module to Model 70 Basic unit with Module Connector cable (if none available, remove Model 70 from cabinet and install 10A in Model 70). Install power transistor test adapter. Mechanically zero all meters.

5.4.2. I_C Meter Calibration

1. Place front panel controls in the following positions:

Test	Reset
Adjust Controls	CCW
Polarity	PNP
Current Range	1 Amp

2. Turn power on and allow 5 minute warm-up.

3. Zero all meters with zero adjustment controls.

4. Connect precision 1 ohm resistor between "E" and "C" terminals using the power transistor test adapter.

5. Connect differential input oscilloscope inputs across 1 ohm resistor. Set scope controls as follows:

Vertical Sensitivity	.2V/Div.
Inputs	A and B
Input Mode	DC
Sweep	1 MS/CM
Sweep Mode	Line

6. Depress TEST Switch.

7. Turn upper adjust control for 1V pulse on scope.

8. Adjust R317 for full scale deflection on M102 (upper, Model 70).

5.4.3 V_{CE} Meter Calibration

1. Place front panel controls in the following positions:

TEST	Reset
ADJUST CONTROLS	CCW
POLARITY	PNP
CURRENT RANGE	1 Amp
VOLTAGE RANGE	10 V

2. Turn power on and allow 5 minute warm-up.

3. Zero all meters with zero adjustment controls.

4. Short E and B Test leads together at test adapter.

5. Connect precision voltmeter (10V f.s.) between (+) and C (-) test terminals.

6. Depress TEST switch -

7. Turn lower adjust control on Model 70 for 10 V indication on external voltmeter.

8. Adjust R316 for full scale indication on M101 (lower, Model 70).

5.5 FACTORY ADJUSTMENTS

5.5.1 Preliminary

The only adjustments to be made on the 10A that are not covered in the calibration instructions involve synchronizing and timing the pulse generator.

Equipment required for these adjustments are a DC Scope and module connector cable (Items 2 and 4, described in calibration procedure).

Connect 10A Test Module to Model 70 basic unit with module connector cable. Connect Model 70 to line voltage with isolating plug.

5.5.2. Synchronization

1. Place front panel controls in the following positions:

ADJUST CONTROLS	CCW
TEST	RESET
POWER SWITCH	ON
R246 SYNC	CCW

5.5.2. Synchronization (continued)

2. Connect scope ground to Terminal 5 on pulse generator PC board.

3. Connect scope input A to Terminal 4 on pulse generator PC board.

VERTICAL Sensitivity	5 V/CM
SWEEP	5 MS/CM
TRIGGER	Line
Input A	DC
Input B	GND

4. Turn R246 clockwise until pulses synchronize with line at 120 cps. Rotate R246 clockwise $\frac{1}{2}$ turn further.

5.5.3. Pulse Width

1. Place front panel controls in the following position:

ADJUST controls	CCW
TEST	Reset
POWER Switch	On

2. Connect scope ground to terminal 5 on pulse generator PC board. Connect input A to terminal 4. Connect input B to the emitter of Q205 (Connection to R258 lead nearest edge of printed circuit board is most conveneient).

VERTICAL Sensitivity	2 V/CM
SWEEP	.02 MS/CM
TRIGGER	-
INPUT A	DC
INPUT B	DC

3. Adjust Sweep for display of pulse output.

4. Adjust pulse width control R252 for 167+20-0 microsecond pulse width.

5. Pulse should appear as shown in figure 5-1.

6. If strobe delay is out of tolerance change value of R256. An increase in the value increases delay.

7. If strobe pulse width is out of tolerance change value of C210. An increase in value increases strobe pulse width.

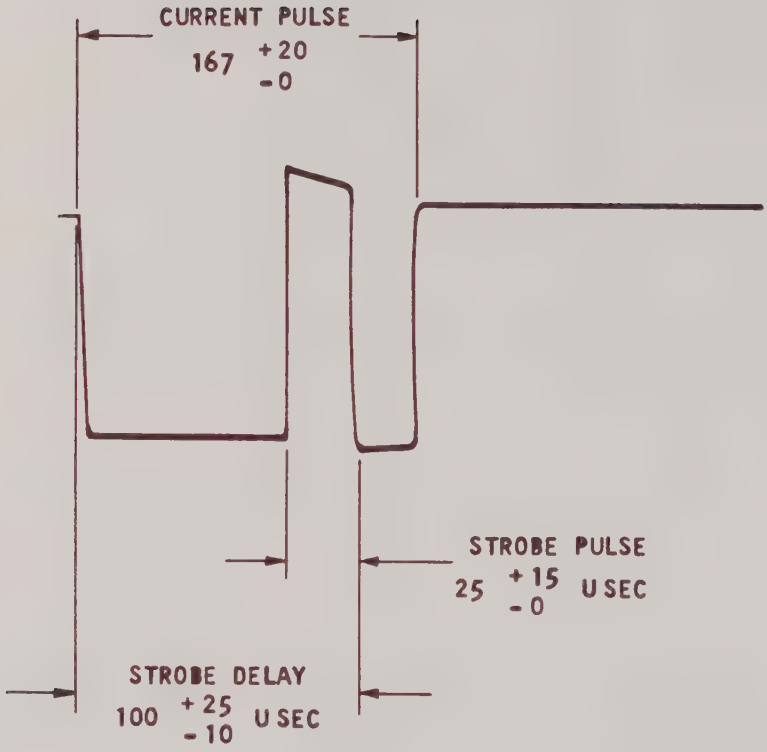


FIGURE 5.1

PULSE WIDTH ADJUSTMENT - OSCILLOGRAPHIC DISPLAY

SECTION 6

PARTS LIST

CAPACITORS	DESCRIPTION	PART NUMBER
C 201	4000 MFD @ 150 VDC Electrolytic	104-017
C 202	.01 MFD @ 600 VDC Disc	100-075
C 203	.01 MFD @ 600 VDC Disc	100-075
C 204	500 MFD @ 25 VDC Electrolytic	104-007
C 205	.1 MFD @ 500 VDC Disc	100-076
C 206	.01 MFD @ 600 VDC Disc	100-075
C 207	.005 MFD @ 1000 VDC Disc	100-077
C 208	500 MFD @ 25 VDC Electrolytic	104-007
C 209	.01 MFD @ 600 VDC Disc	100-075
C 210	.01 MFD @ 600 VDC Disc	100-075
C 211	.01 MFD @ 600 VDC Disc	100-075
C 212	1 MFD @ 15 VDC Electrolytic	104-015
C 213	.005 MFD @ 1000 VDC Disc	100-077
C 214	10-20-30 MFD @ 350 VDC Electrolytic Triple	104-200
C 215	80 MFD @ 300 VDC Electrolytic	104-018
C 216	200 MMFD @ 1000 VDC Disc	100-025
C 217	.1 MFD @ 500 VDC Disc	100-076
C 218	.1 MFD @ 500 VDC Disc	100-076
C 219	.1 MFD @ 500 VDC Disc	100-076
C 220	1 MFD @ 50 VDC Electrolytic	104-019
C 221	40 MFD @ 6 VDC Electrolytic	104-004
C 222	40 MFD @ 6 VDC Electrolytic	104-004
C 223	.01 MFD @ 600 VDC Disc	100-075
C 224	12 MMFD @ 500 VDC Mica	101-001
C 225	.01 MFD @ 600 VDC Disc	100-075
C 226	.1 MFD @ 500 VDC Disc	100-076
C 227	.1 MFD @ 500 VDC Disc	100-076
DIODES		
D 201	SCBR 3	740-015
D 202	SC 1	740-006
D 203	SC 1	740-006
D 204	SC 1	740-006
D 205	SCBR 6	740-009
D 206	6 Volt Zener Diode	740-014
D 207	1N457	740-013
D 208	1N457	740-013
D 209	1N457	740-013
D 210	1N457	740-013
D 211	1N457	740-013
D 212	6 Volt Zener Diode	740-014
D 213	1N457	740-013
D 214	1N457	740-013
D 215	1N457	740-013
D 216	1N457	740-013

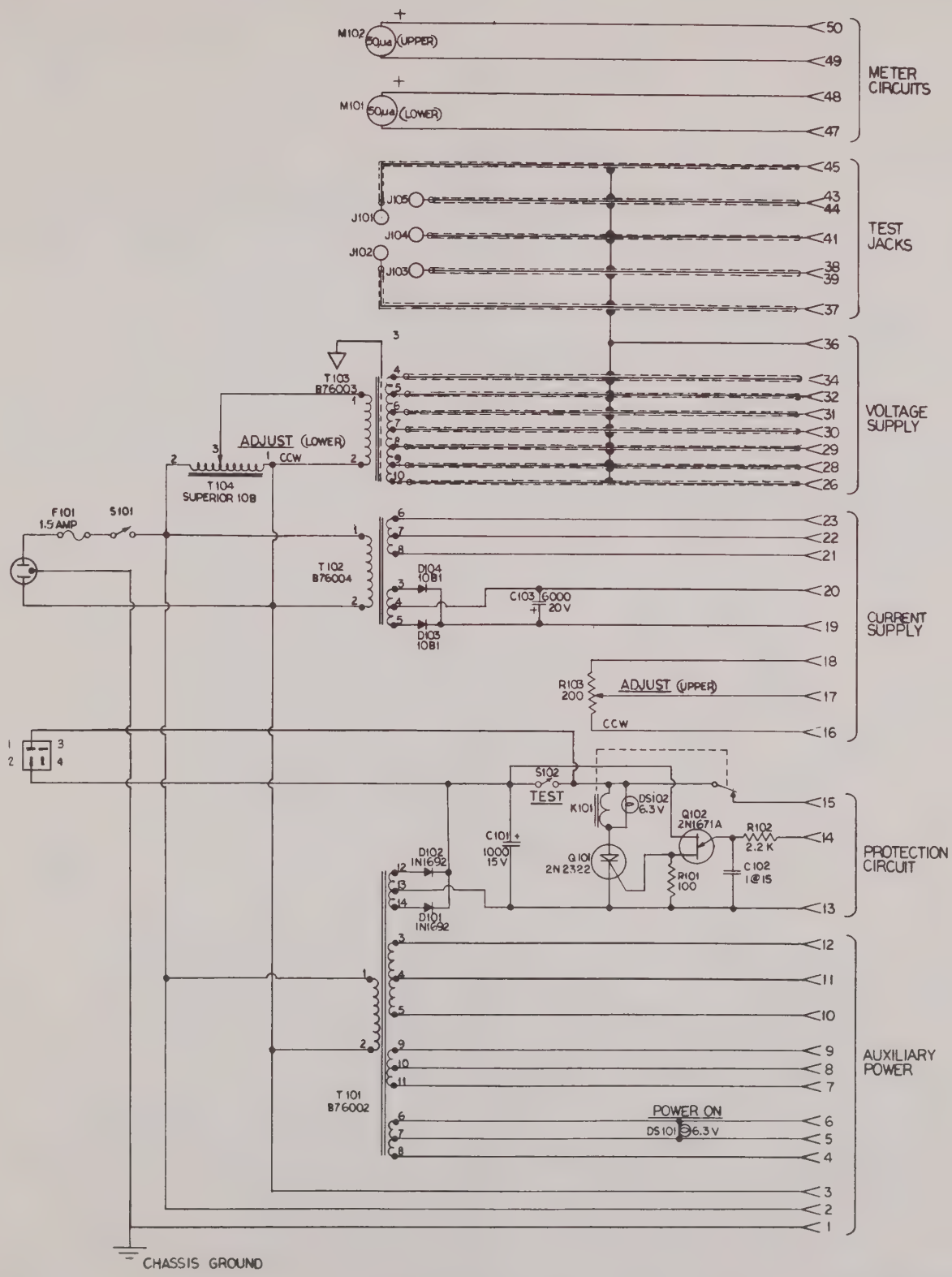
RELAY	DESCRIPTION	PART NUMBER
K 201	3 PDT 6 VDC	540-005
LAMPS		
N 201	55 ST 2S Neon	340-001
N 202	55 ST 2S Neon	340-001
METER		
M 201	100-0-100 MA	400-000
TRANSISTORS		
Q 201	2N1671A Unijunction	741-000
Q 202	2N1308 NPN	741-003
Q 203	2N1175 PNP	741-002
Q 204	2N1671A Unijunction	741-000
Q 205	2N1175 PNP	741-002
Q 206	2N1308 NPN	741-003
Q 207	2N1175 PNP	741-002
Q 208	2N1175 PNP	741-002
Q 209	2N1544 Power PNP	741-001
Q 210	2N2156 Power PNP	741-004
RESISTORS		
R 201	33 Ohm	550-002
R 202	100 Ohm, 1 Watt	550-029
R 203	350 Ohm, 5 Watt, 10% Wirewound	553-101
R 204	1K, 10 Watt, 10% Wirewound	553-100
R 205	10K	550-101
R 206	3.3K	550-077
R 207	1K	550-053
R 208	330 Ohm	550-051
R 209	100 Ohm	550-026
R 210	33 Ohm	550-002
R 211	10 Ohm	550-001
R 212	3.3 Ohm, 2 Watt, Wirewound	553-012
R 213	.82 Ohm, 2 Watt, Wirewound	553-015
R 214	.24 Ohm, 2 Watt, 5% Wirewound	553-016
R 214A	.24 Ohm, 2 Watt, 5% Wirewound	553-016
R 215	7M, 1% Dep. Carbon	551-084
R 216	2M, 1% Dep. Carbon	551-075
R 217	700K, 1% Dep. Carbon	551-088
R 218	300K, 1% Dep. Carbon	551-086
R 219	1K, 1% Dep. Carbon	551-001
R 220	333 Ohm, 1% Dep. Carbon	551-002
R 221	100 Ohm, 1% Ep. Carbon	551-003
R 222	33.3 Ohm, 1% Wirewound	553-054
R 223	10.0 Ohmk 1% Wirewound	553-025
R 224	3.33 Ohm, 1% Wirewound	553-008
R 225	1.0 Ohm, 1% Wirewound	553-007

RESISTORS (continued)	DESCRIPTION	PART NUMBER
R 226	.333 Ohm, 1% Wirewound	553-006
R 227	.100 Ohm, 1% Wirewound	553-009
R 228	.0333 Ohm, 1% Wirewound	553-010
R 229	11.1K, 1% Dep. Carbon	551-050
R 230	3.45K, 1% Dep. Carbon	551-027
R 231	1.01K, 1% Dep. Carbon	551-030
R 232	333 Ohm, 1% Dep. Carbon	551-002
R 233	100 Ohm, 1% Dep. Carbon	551-003
R 234	33.3 Ohm, 1% Wirewound	553-054
R 235	10.0 Ohm, 1% Wirewound	553-025
R 236	3.33 Ohm, 1% Wirewound	553-008
R 237	1.0 Ohm, 1% Wirewound	553-007
R 238	.333 Ohm, 1% Wirewound	553-006
R 239	1M, 1% Dep. Carbon	551-079
R 240	10.1K, 1% Dep. Carbon	551-054
R 241	11.1K, 1% Dep. Carbon	551-050
R 242	90K, 1% Dep. Carbon	551-055
R 243	100K, Precision Potentiometer	555-075
R 244	1K	550-053
R 245	1K	550-053
R 246	500K, Trimpot, Variable	554-082
R 247	100 Ohm	550-026
R 248	47 Ohm	550-000
R 249	470K	550-152
R 250	220 Ohm	550-050
R 251	100 Ohm	550-026
R 252	1K, Trimpot, Variable	554-000
R 253	4.7K	550-078
R 254	220 Ohm	550-050
R 255	220 Ohm	550-050
R 256	10K	550-101
R 257	100 Ohm	550-026
R 258	1K	550-053
R 259	220 Ohm	550-050
R 260	220 Ohm	550-050
R 261	220 Ohm	550-050
R 262	820 Ohm	550-058
R 263	4.7K	550-078
R 264	220 Ohm	550-050
R 265	220 Ohm	550-050
R 266	1K	550-053
R 267	2.7K	550-076
R 268	470 Ohm, 1 Watt	550-057
R 269	1.5K, 2 Watt	550-085
R 270	1K, 2 Watt	550-055
R 271	3K, 5 Watt, Wirewound	553-125
R 272	100 Ohm	550-026
R 273	2K, Variable	554-027
R 274	47K	550-126
R 275	47K	550-126

RESISTORS (continued	DESCRIPTION	PART NUMBER
R 276	1K	550-053
R 277	1K	550-053
R 278	470 Ohm	550-052
R 279	470 Ohm	550-052
R 280	100K	550-127
R 281	100K	550-127
R 282	100K	550-127
R 283	100K	550-127
R 284	180K	550-155
R 285	150K	550-156
R 286	27K	550-128
R 287	25K, Variable	554-051
R 288	27K	550-128
R 289	2.7M	550-178
R 290	1.5M	550-179
R 291	1.5M	550-179
R 292	33K	550-125
R 293	100K	550-127
R 294	1K	550-053
R 295	15M	550-186
R 296	1K	550-053
R 297	1K	550-053
R 298	220K	550-150
R 299	18K	550-104
R 300	3.9K	550-083
R 301	1M	550-175
R 302	220K	550-150
R 303	1M	550-175
R 304	3.9K	550-083
R 305	100K	550-127
R 306	100K	550-127
R 307	47K, 1 Watt	550-137
R 308	1K	550-053
R 309	470 Ohm	550-052
R 310	470 Ohm	550-052
R 311	1K	550-053
R 312	100K	550-127
R 313	2K, Variable	554-027
R 314	3.9K	550-083
R 315	100K	550-127
R 316	50K, Variable	554-050
R 317	1M, Variable	554-075
R 318	100K	550-127

SWITCHES		
S 201	Rotary 2 Pole, 4-Position (NS)	A76109
S 202	Rotary 8 Pole, 10-Position (S)	A76114
S 203	Lever 2 Pole, 2-Position (NS)	A76125
S 204	Slide Switch DPDT	874-001

TRANSFORMER	DESCRIPTION	PART NUMBER
T 201	Pulse Transformer	B76117
TUBES		
V 201	6C4	910-102
V 202	0A2	910-000
V 203	0A2	910-000
V 204	12AT7A	910-155
V 205	12AX7A	910-150
V 206	12AT7A	910-155
V 207	12AT7A	910-155
V 208	12AX7A	910-150
V 209	12AX7A	910-150
CHOPPER		
X 201	Chopper DPDT, 6.3 VAC	125-000



4 RESISTANCES IN OHMS.
3. UNDERLINED CONTROL DESIGNATIONS APPEAR ON FRONT PANEL
2 CAPACITANCES IN µfd.
1. RESISTORS ½W, ±10%, CARBON.

NOTES: UNLESS OTHERWISE SPECIFIED.

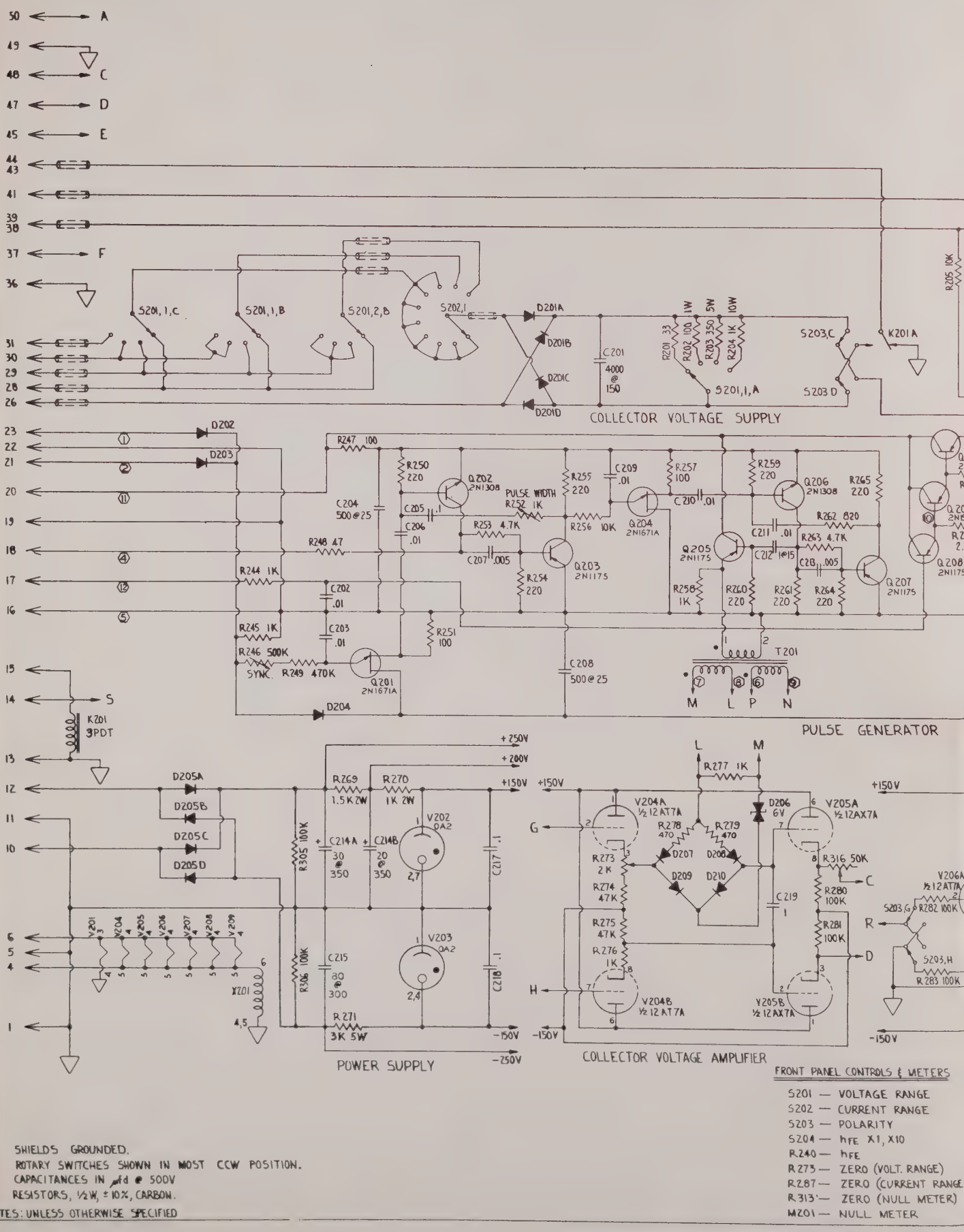
REV.	DESCRIPTION	DATE	DRWN	APPD
D	GROUNDED TERMINAL 3 ON T 103	3-1-64	E.B.	RM
C	REMOVED R 104, R 105 & D105. REV. PROTECT. CIRC., R101 WAS 220Ω R102 WAS 100Ω, C102 WAS 5, Q 101 WAS TI 145A0	4-29-63	E.B.	RM
B	ADDED D10 5 IN118	3-18-63	L.M.	
A	Q102 WAS 2N1761, R102 WAS 100K, C102 WAS .25, NOTE #4 ADDED. F101 WAS 1 AMP.	2/22/63	A.V.K.	RM

REVISIONS

BIRTCHER CORP/INDUSTRIAL DIVISION

MODEL 70
SEMICONDUCTOR TEST SET
BASIC UNIT
SCHEMATIC

DRWN: A.V.K.	APPD: RM	REV.
DATE: 6.25.62.	DATE: 6.26.62	D

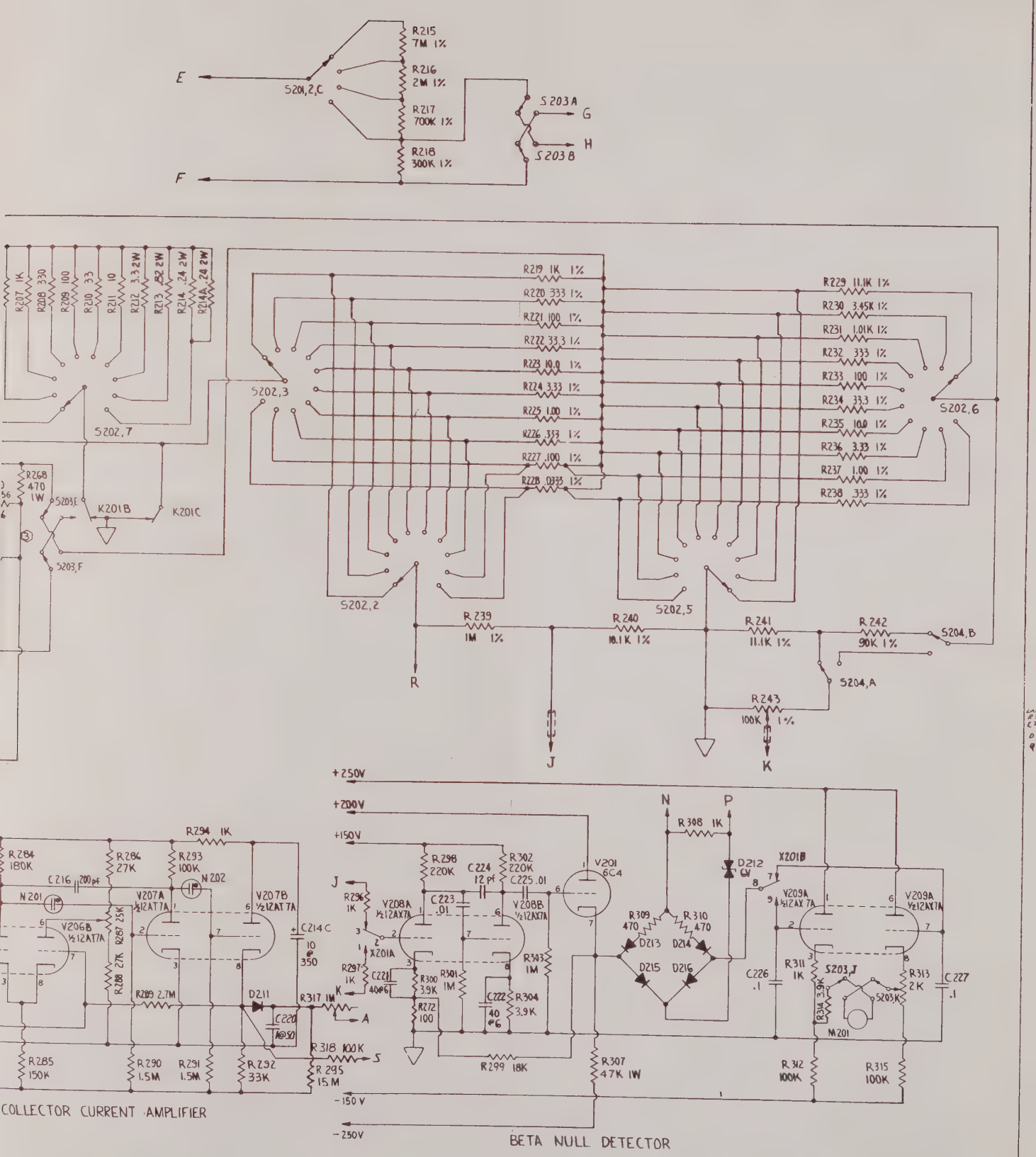


FRONT PANEL CONTROLS & METERS

- S201 — VOLTAGE RANGE
- S202 — CURRENT RANGE
- S203 — POLARITY
- S204 — h_{FE} X1, X10
- R240 — h_{FE}
- R273 — ZERO (VOLT. RANGE)
- R287 — ZERO (CURRENT RANGE)
- R313 — ZERO (NULL METER)
- M201 — NULL METER

NOTES: UNLESS OTHERWISE SPECIFIED

1. RESISTORS, ½W, ± 10%, CARBON.
2. CAPACITANCES IN µfd @ 500V
3. ROTARY SWITCHES SHOWN IN MOST CCW POSITION.
4. SHIELDS GROUNDED.



ISSUE	DESCRIPTION	DATE	DRN	APP.
	REVISIONS			
D	R 271 WAS 3.3 K 2W	3-19-64	E.B.	RM
C	R 270 WAS 1.5 K 2W. ; R295 WAS 2.7M AND S 203 A & B WAS BETWEEN 'E' & 'F'	10-7-63	E.B.	RM
B	REVISED	9-6-63	A.W.	RM
A	ADDED R272, R299 – C224 WAS 27 pf. - X201 WAS CHOPPER	7-29-63	A.W.	RM

THE BIRTCHER CORP - INDUSTRIAL D.I.S.ION

SCHEMATIC
PULSED BETA TEST MODULE
TYPE 10-A

DRAWN: E.B. | APPROVED: RM | REV.
DATE: 7-22-63 | DATE: 7-22-63 | D

DISTRIBUTION 6

WARRANTY

All our products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing parts which prove to be defective during the warranty period. We are not liable for consequential damage.

For assistance of any kind, including help with instruments under warranty, contact your authorized Birtcher sales representative for instructions. Give full details of the difficulty and include the instrument model and serial number. Service data or shipping instructions will be promptly sent to you. There will be no charge for repair of instruments under warranty, except transportation charges. Estimates of charges for non-warranty or other service work will always be supplied if requested before work begins.

Serial Number 10A

SECTION 5

CALIBRATION

PRELIMINARY

The Model 70 is a stable instrument and should not require frequent calibration, however, a periodic performance check is desirable from the standpoint of preventative maintenance.

The following equipment is necessary for a complete performance check of the Model 70 Test Set:

1. Precision DC microampmeter to read 50 microamps with 1% accuracy. Simpson Model 1703 or equivalent.

2. Voltage source 0 to 250 millivolts.

3. Millivoltmeter to read 125 millivolts with 1% accuracy. Weston 622 or equivalent.

4. Amphenol plug type 57-10500.

Connect the voltage supply to pins 47 and 48 as shown in figure 5-1.

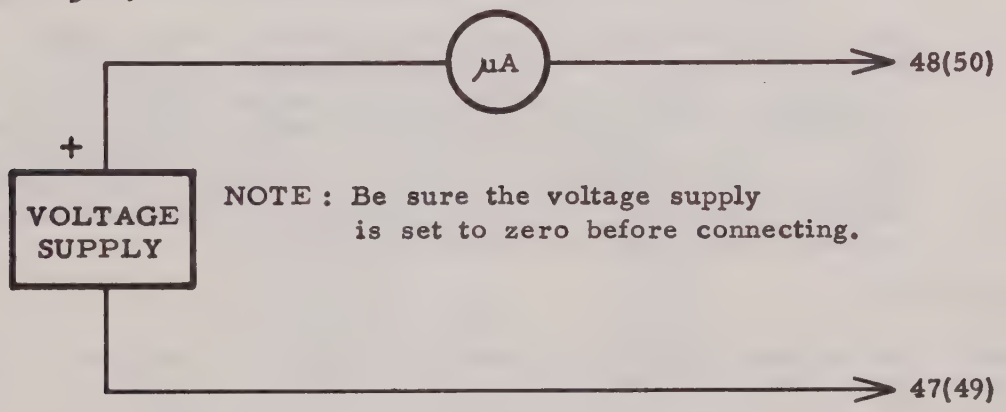


Figure 5-1 CURRENT CALIBRATION.

LOWER METER

1. Slowly increase the current by adjusting the voltage supply output for full scale reading on the bottom meter of the Model 70. The standard should read 50 microamps $\pm$ 1%.

2. Decrease the current to each cardinal point and check the meter. All points should be $\pm$ 1% fo full scale.

3. Connect the voltage supply and millivoltmeter as shown in figure 5-2.

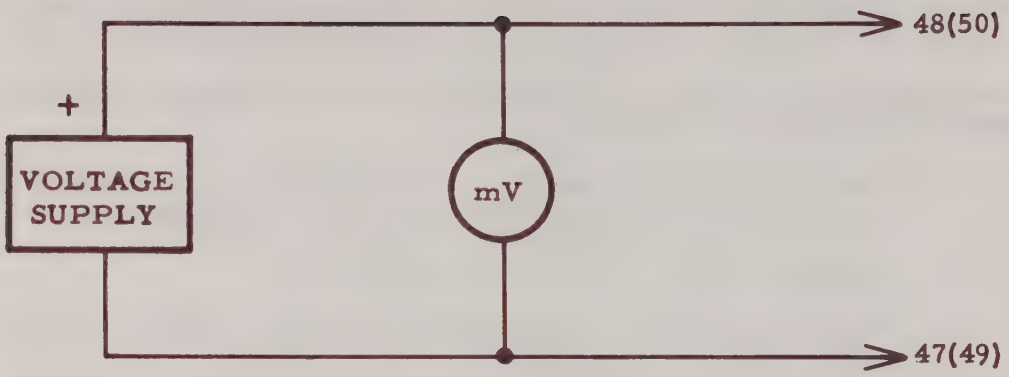


Figure 5-2 VOLTAGE CALIBRATION.

4. Adjust the voltage supply output until lower meter reads full scale. The standard should read 125 $\pm$ 1 millivolt. On units with serial numbers 70-1-1 thru 70-2-100, if the tolerance is not met, adjust R104 and R105. These variable resistors are located inside the Model 70 unit behind the meters. On units with serial numbers beginning 70-3-1 the meters are pre-calibrated and no adjustment can be made.

UPPER METER

Connect the voltage supply as shown in figure 5-1 to pins 49 and 50 and repeat steps 1 thru 4.

MODEL 10 DC CALIBRATION

PRELIMINARY

The type 10 DC Test Module is a stable instrument and should never require internal adjustment affecting calibration, however, a periodic performance check is desirable from the standpoint of preventative maintenance. The following equipment is necessary for complete performance check of the 10 DC Test Module.

1. Precision DC microamp meter 0-1 ma. 1% accuracy. Simpson Model 1702, 1703 or equivalent.

2. Precision Voltmeter cover range from 3 - 300 volts with 1% accuracy. Simpson Model 1700 or equivalent.

Connect the 10 DC to the Model 70. Install power transistor test adapter. Mechanically zero all meters.

I_C Meter

1. Place front panel controls in the following positions:

TEST	RESET
ADJUST CONTROL	CCW
POLARITY	PNP
IC RANGE	1 ma.
CURRENT RANGE	1 ma.
FUNCTION	VCE

2. Connect microamp meter between emitter + and collector - test jacks.

3. Depress TEST Switch.

4. Increase I_C adjust control (upper, Model 70) for 1 ma. indication on external meter. I_C meter should indicate full scale + or - 2%.

CURRENT METER

1. Place front panel controls in the following position:

TEST	RESET
ADJUST CONTROL	CCW
POLARITY	PNP
CURRENT RANGE	1 ma.
FUNCTION	VCE SAT

2. Connect microamp meter between emitter (+) and base (-) test jacks.

3. Depress TEST switch.

4. Increase Lower ADJUST control, (Model 70) for 1 ma. indication on external meter. Current range meter should indicate full scale ± 2%.

VOLTMETER

1. Place front panel controls in the following positions:

TEST	RESET
ADJUST CONTROLS	CCW
POLARITY	PNP
VOLTAGE RANGE	100
FUNCTION	I_{CBO}

2. Connect voltmeter (100 volt full scale range) between collector (-) and base (+) test jacks.

3. Depress TEST Switch.

4. Increase Lower ADJUST control for 100 volt indication on external voltmeter. The DC meter should indicate full scale ± 2%.